

HY-700
User's Guide
and
Programmer's
Manual



WISE

Copyright Notice

© 1999 Microsoft Corporation. All rights reserved.

Information provided by this software is described in it and is copyrighted by Microsoft Corporation. The software described in this document is furnished under a license agreement. You may not reproduce, transmit, distribute, store, or transmit, in any form or by any means, electronic, mechanical, or otherwise, any part of this publication without the express written permission of Microsoft Corporation. Except for material having copyright notice, all other material in the software is provided with this product.

Trademarks

EXCEL is a registered trademark of Microsoft Technology.

EXCEL 97 is a trademark of Microsoft Technology.

EXCEL 97 is a trademark of Microsoft Technology.

EXCEL 97, EXCEL 97, and EXCEL 97 are registered trademarks of International Business Machines.

Microsoft is a registered trademark of Microsoft Corporation.

MS is a trademark of Microsoft Corporation.

Microsoft is a registered trademark of Microsoft Corporation.

Microsoft is a trademark of Microsoft Corporation.

Microsoft is a trademark of Microsoft Corporation.

Microsoft is a registered trademark of Microsoft Corporation.

Disclaimer

Microsoft Technology makes no representation or warranty regarding the contents of this document. Microsoft Technology reserves the right to make changes to the specifications of the product described herein without notice. Microsoft Technology and its subsidiaries are not responsible for any errors or omissions in this document, and without obligation to correct any errors or omissions.

User's Guide

OVERVIEW

This User's Guide introduces the system components: a monochrome monitor, a graphics adapter card, and the IBM PC or PC-compatible computer to which the system is connected. It also describes the software--color and graphics as well as the hardware.

HOW TO USE THIS MANUAL

Refer to:

- o Chapter 1, "Subsystem Overview," for a description of the monitor's features and a quick summary of how to use it.
- o Chapter 2, "Installation," to install the monitor, the graphics adapter card in your computer and to setup your system, and in case you need start-up troubleshooting information.
- o Chapter 3, "Applications Programs," for information on how to run IBM PC-compatible text and color/graphics applications programs in their respective display modes.
- o Chapter 4, "Utility Programs," for an explanation of the subsystem's utility programs, which give you access to the monitor's high-resolution screen capabilities.
- o Appendix A, "Specifications," for monitor and display adapter card specifications.
- o The Programmer's Manual if you want to modify existing application programs, or write new programs to run in the monitor's enhanced high-resolution display modes.

TABLE OF CONTENTS

1 GRAPHICS SUBSYSTEM OVERVIEW

Subsystem Description.....	1
Subsystem Features.....	2
Enhanced Display Characteristics.....	3
Standard IBM PC-Compatible Display Modes.....	4
High-Resolution Modes.....	5
Summary of Graphics Subsystem Capabilities.....	6

2 INSTALLATION

Getting Ready.....	7
Preparing the Display Adapter Card.....	8
Jumpers Settings.....	9
Installing the Display Adapter Card.....	10
Power-Up Display Mode.....	11
Installing the Monitor.....	12
Operator Controls.....	13
Operating the Monitor.....	14
Troubleshooting.....	15

3 APPLICATIONS PROGRAMS

Running Applications Programs.....	16
Selecting IBM PC-Compatible Display Modes.....	17
High-Resolution Modes.....	18

4 UTILITY PROGRAMS

Overview.....	4-2
Loading the Utility Programs.....	4-2
Running the Utility Programs.....	4-3
Memory-Resident Programs.....	4-11
Load Commands.....	4-11

APPENDIX A--SPECIFICATIONS..... A-1

INDEX..... I-1

LIST OF TABLES

1-1 User-Selected IBM PC-Compatible Text Modes.....	1-5
1-2 Automatically Selected IBM PC-Compatible Color/Graphics Modes.....	1-5
1-3 Subsystem's High-Resolution Text Modes.....	1-6
1-4 Subsystem's High-Resolution Graphics Modes.....	1-7
1-5 Summary of Graphics Subsystem Characteristics.....	1-8
1-6 Common Applications Program Modes.....	1-6

LIST OF FIGURES

2-1 Jumper Locations on Display Adapter Card.....	2-5
2-2 Monitor Installation.....	2-6
2-3 Operator Controls.....	2-7
2-5 Checking the Fuse.....	2-9

1 GRAPHICS SUBSYSTEM OVERVIEW

Subsystem Description

Subsystem Features

Enhanced Display Characteristics..

Standard IBM PC-Compatible Display Modes.....

IBM PC-Compatible Text Modes.....	
IBM PC-Compatible Color/Graphics Modes.....	

High-Resolution Modes.....

High-Resolution Text Modes.....	
High-Resolution Graphics Modes.....	

Summary of Graphics Subsystem Characteristics.....

SUBSYSTEM DESCRIPTION

This extraordinary monochrome monitor, together with its display adapter card and utility programs, is a graphics subsystem. This subsystem is unique because it allows you to run both IBM PC-compatible Monochrome and Color/Graphics Adapter (CGA) programs (converted from 16 colors into four shades of gray), as well as special high-resolution graphics applications, on a monochrome display.

The graphics subsystem can be installed in your IBM PC, PC/XT, PC-AT, or PC-compatible computer.

This subsystem's lowest text and graphics resolutions are superior to the typical resolutions available on other monitors. This means that not only can you run both IBM text and CGA programs on this monitor, what you see on your display screen is at all times much sharper and clearer than standard displays (see "Enhanced Display Characteristics" in this chapter). This is in addition to the enhanced high-resolution modes this subsystem makes available to you!

The utility programs, included on an accompanying diskette, allow you to take full advantage of the enhanced screen capabilities provided by the display adapter card--particularly the ability to select high-resolution display modes from a range of choices.

See "Summary of Graphics Subsystem Characteristics" at the end of this chapter for a quick-reference table showing the wide variety of display options available to you with this subsystem.

Note--This graphics subsystem does not negatively affect any equipment (such as a printer, modem, or mouse) that plugs into your computer's serial port(s).

SUBSYSTEM FEATURES

With its easy advanced features, you can:

- Offers five IBM PC-compatible text resolutions and a high-resolution graphics mode
- Provides a high-resolution mode (see page 100) (compared to IBM's standard 640x480 mode)
- Allows you to create special screen modes
- Displays (in its lowest resolution) 14x28 pixel alphanumeric characters and 8x8 pixel graphics (compared to IBM's standard 8x8 pixel)
- Allows an extended 160 column by 50 line display of clearly readable text
- Displays four shades of gray in both text and graphics emulate IBM Color/Graphics
- Allows many applications programs to use screen modes and graphics display modes automatically
- Allows a choice of two character fonts
- Works with the IBM PC family (XT, AT) and with any PC-compatible computer
- Runs with any operating system, and needs no special drivers to run in IBM PC-compatible modes
- Provides a 15-inch white phosphor screen for maximum display
- Lets you select the time lapse until the display times itself off (to prolong the life of the screen's phosphor)

ENHANCED DISPLAY CHARACTERISTICS

The monitor's enhanced display characteristics are the result of an increased number of pixels per graphic dot (for graphics applications) and per character cell (for alphanumeric applications). This enhanced resolution eliminates "jaggies" (the rough edges often found around alphanumeric characters and graphics), allowing more easily seen detail.

Note--The term "graphic dot," as used in this User's Guide, refers to what normally appears as a pixel on typical, standard-resolution displays. For example, the pixel displayed by standard IBM Color/Graphics Adapter programs appears on the high-resolution subsystem display as a tight matrix of eight pixels. This characteristic is a function of the enhanced (1280 x 800 pixel) resolution of the monitor.

Tables 1-1 through 1-4, in the following sections, show the horizontal and vertical configurations of pixels for the character cells and graphic dots used by the monitor.

STANDARD IBM PC-COMPATIBLE DISPLAY MODES

The five display modes listed in Tables 1-1 and 1-2 are the standard modes that run all existing off-the-shelf applications programs written for the IBM PC and for IBM PC-compatible computers. Three of these modes (Table 1-1) are designed to run text. The other two modes (Table 1-2) run a variety of graphics programs, including games such as Flight Simulator.

IBM PC-Compatible Text Modes

Text (alphanumeric) modes are unique in that you can select them from the keyboard using the MS-DOS MODE commands (as described in Chapter 3, "Applications Programs"). Table 1-1 lists the three standard IBM PC-compatible text modes you can select.

Table 1-1 User-Selected IBM PC-Compatible Text Modes

Display Mode	Character Display Format	Color	Pixels/Graphic Dot*
IBM Monochrome	80 char. x 25 lines	Black and white	8 x 8
IBM Color/Graphics	80 char. x 25 lines	4 shades of gray	8 x 8
IBM Color/Graphics	40 char. x 25 lines	4 shades of gray	8 x 8

*Horizontal x vertical configuration of pixels

IBM PC-Compatible Color/Graphics Modes

Two additional standard IBM PC-compatible Color/Graphics modes, described in Table 1-2, can be selected only automatically by Color/Graphics Adapter applications programs.

Table 1-2 Automatically Selected IBM PC-Compatible Color/Graphics Modes

Display Mode	Graphic Dot* Display Format	Color	Pixels/Graphic Dot*
IBM Color/Graphics	320 x 200	4 shades of gray	8 x 8
IBM Color/Graphics	640 x 200	Black and white	2 x 8

*Horizontal x vertical configuration of pixels and graphic dots

HIGH-RESOLUTION MODES

In addition to the standard modes described in the previous section, you can use--for special applications programs only--six unique high-resolution monochrome display modes. These are listed in Tables 1-3 and 1-4.

Note--To make full use of the high-resolution capabilities of the graphics subsystem with IBM PC-compatible applications programs, you need special drivers that are adapted by a programmer or software vendor. See the Programmer's Manual for complete information.

High-Resolution Text Modes

The subsystem's three high-resolution text (alphanumeric) modes that you can select are listed in Table 1-3.

Note--You can only select text modes (both standard and high-resolution) from the keyboard.

Table 1-3 Subsystem's High-Resolution Text Modes

Display Mode	Character Display Format	Pixels/Character Cell*
Alphanumeric	80 characters x 50 lines	16 x 16
Alphanumeric	160 characters x 25 lines	8 x 32
Alphanumeric	160 characters x 50 lines	8 x 16

*Horizontal x vertical configuration of pixels

High-Resolution Graphics Modes

Three unique high-resolution graphics (1600 x 1200 and 1280 x 1024) graphics applications programs can be used with the

Note--Origin, 1600 x 1200 and 1280 x 1024 are not standard resolutions. They are automatic, 1600 x 1200 and 1280 x 1024.

Table 1-4 Subsystem's High-Resolution Graphics Modes

Display Mode	Graphic Dot* Display Format	Color	Pixels/Character Cell*
Graphics	640 x 400	16 colors	16 x 16
Graphics	1280 x 400	16 colors	8 x 32
Graphics	1280 x 800	16 colors	8 x 16

*Horizontal x vertical configuration of pixels and color

SUMMARY OF GRAPHICS SUBSYSTEM CHARACTERISTICS

This graphics subsystem gives you a far wider range of choices than other monitors on the market. Table 1-4 summarizes the choices you have, including the resolution and color selections, and shows the results of those selections in both resolution and color.

Note--Chapter 3, "Applications Programs," 1600 x 1200 and 1280 x 1024 Programs," give detailed instructions on how to make selections with this graphics subsystem.

Table 1-5 Summary of Graphics Subsystem Characteristics

Function	Display Mode	Display Format (Horizontal x Vertical)	Resolution		Color	Implementation Mode by
			This Subsystem	Standard		
Standard Text	IBM Monochrome	80 characters x 25 lines	15 x 32*	8 x 8*	Black and white	IBM PC/XT/AT
	IBM Color/Graphics	80 characters x 25 lines	16 x 32*	8 x 8*	4 shades of gray	IBM PC/XT/AT
	IBM Color/Graphics	40 characters x 25 lines	32 x 32*	9 x 16*	4 shades of gray	IBM PC/XT/AT
High-Resolution Text	Alphanumeric	80 characters x 50 lines	16 x 16*		4 shades of gray	IBM PC/XT/AT
	Alphanumeric	160 characters x 25 lines	8 x 32*		Black and white	IBM PC/XT/AT
	Alphanumeric	160 characters x 50 lines	8 x 16*		Black and white	IBM PC/XT/AT
Standard Color/Graphics	IBM Color/Graphics	320 x 200 graphic dots	4 x 4**		4 shades of gray	IBM PC/XT/AT
	IBM Color/Graphics	640 x 200 graphic dots	2 x 1**		Black and white	IBM PC/XT/AT
High-Resolution Graphics	Graphics	640 x 400 graphic dots	2 x 2**		4 shades of gray	IBM PC/XT/AT
	Graphics	1280 x 400 graphic dots	1 x 2**		Black and white	IBM PC/XT/AT
	Graphics	1280 x 800 graphic dots	1 x 1**		Black and white	IBM PC/XT/AT

*Resolution in pixels per character cell

**Resolution in pixels per graphic dot

2 INSTALLATION

Getting Ready.....	2-1
Preparing the Display Adapter Card.....	2-2
Jumpers Settings.....	2-3
Installing the Display Adapter Card.....	2-4
Power-Up Display Mode.....	2-5
Installing the Monitor.....	2-6
Operator Controls.....	2-7
Operating the Monitor.....	2-8
Troubleshooting.....	2-9

GETTING READY

Instructions in this chapter describe how to:

- Install
- Operate
- Troubleshoot

the graphics subsystem monitor and the display adapter. When you unpack the monitor, you should find the items listed below. You'll also need a 1/8-inch flat blade screwdriver to connect the video cable.

- Manual
- Utility diskette
- Monitor
- Power cord
- Video cable
- Display adapter card

PREPARING THE DISPLAY ADAPTER CARD

If this is the only monitor and display adapter you are connecting to your computer system, you must change the jumper settings on the display adapter.

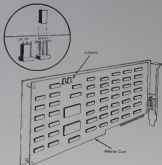
Caution--Some computers have built-in display adapters that emulate a monochrome or color display. If you are using such a computer and are going to add a new display adapter, you must disable the built-in display adapter. (Refer to your computer manual for instructions.)

JUMPER SETTINGS

If you're adding this new monitor and display adapter to a computer system that has an existing display adapter, the jumper settings on the new display adapter must be set as follows:

- If the existing display adapter is monochrome, set the MONO jumper on the new display adapter to the ON position. Leave the COLOR jumper in the ON position.
- If the existing display adapter is color, set the COLOR jumper on the new display adapter to the ON position. Leave the MONO jumper in the OFF position.

Figure 2-1 Jumper Locations on Display Adapter Card



INSTALLING THE DISPLAY ADAPTER CARD

Turn off the computer and unplug the power cord from the back of the computer. Install the display adapter card in a slot on the back of the computer. (Follow the adapter card and computer manuals for more information.)

POWER-UP DISPLAY MODE

If your system sets the power-up display mode with a switch, set the switch to the correct mode. (Most IBM PCs, PC/XTs, PC/ATs, and most PC-compatible systems use a switch before reassembling your computer. See your computer manual for information on how to set these switches.)

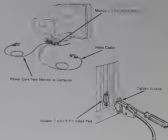
If you have an IBM PC-AT or compatible, you must also use your computer's SETUP utility to configure the power-up display mode. Run SETUP after reassembling and booting for the first time.

INSTALLING THE MONITOR

Place the monitor on top of or near your computer. Remember to leave at least three inches of clearance above and around the monitor for air circulation and cables. Install the monitor (referring to Figure 2-2).

1. Attach one end of the video cable to the 9-pin port on the rear panel of the monitor. Tighten the screws on both sides of the video cable connector with a screwdriver.
2. Find the 9-pin video port on this display adapter. Attach the free end of the video cable to the video port. Tighten the screws on both sides of the video cable connector.
3. Connect the female end of the power cord to the power receptacle on the monitor. Connect the male end to the power receptacle on the computer.

Figure 2-2 Monitor Installation



OPERATOR CONTROLS

The monitor has two operator controls (see Figure 2-3):

- 1. The ON/OFF switch is on the monitor's rear panel.
- 2. The BRIGHTNESS thumbwheel, on the lower-right corner of the monitor, adjusts the screen intensity.

By tilting and turning the monitor, you can make the viewing angle more comfortable.

Figure 2-3 Operator Controls



OPERATING THE MONITOR

Now you're ready to operate the monitor.

1. Plug the female end of the computer's power cord into the receptacle on the computer.
2. Plug the male end of the computer's power cord into a grounded, 3-pronged wall socket.
3. Turn on the monitor.
4. Turn on the computer.

Make sure the display on the screen that identifies your computer and operating system. It should look something like this:

Microsoft MS-DOS version 1.11
Copyright 1981,82,83 Microsoft Corp.

Command v. 1.11
Current date is Tue 1-01-1988
Enter new date:

Refer to your computer's MS-DOS documentation and to Chapter 4 of this User's Guide for instructions on copying the subsystem's utility program's diskette files to your computer.

TROUBLESHOOTING

If you don't see any text displayed on the monitor screen,

1. Make sure the ON/OFF switch is on.
 2. Turn the BRIGHTNESS thumbwheel clockwise.
 3. Check the power cord connections.
 4. Check the video cable connections on the monitor and the display adapter.
 5. Check your computer's manual to make sure you've installed your computer, adapter card, and operating system correctly.
 6. Check system settings that control video output within your computer, if you can do so without voiding your warranty.
- If none of the above is the problem, check the fuse (see "Fuses" section).

Checking the Fuse

Turn off the computer and unplug the power cord from the wall outlet. Check the fuse on the back of the monitor's rear panel. To install the video cable.

Figure 2-4 Checking the Fuse



If the small wire in the fuse is blackened or broken, replace it with a fast-blow, 250-volt, 1.0-amp fuse. Put the wire back in the holder and twist the holder back into the rear panel of the computer and turn both the computer and the monitor on.

If you still don't see text displayed on the monitor screen, checking the computer, the monitor, the software installation, and the fuse, call your local dealer.

1 APPLICATIONS PROGRAMS

Running Applications Program.....

Selecting IBM PC-Compatible Display Modes.
Determining the Correct Mode.....
Troubleshooting Mode Problems.....
Common Applications and Modes.....

High-Resolution Modes.....

RUNNING APPLICATIONS PROGRAMS

The easiest way to make sure that all of your applications program work correctly is to install them all for either an IBM Monochrome or Color/Graphics Adapter display.

Make sure that the system is configured to power-up in either monochrome or color/graphics mode (see "Power-Up Display Mode" in Chapter 2).

Note--Typical users will only need to use the MS-DOS MODE commands MONO (for monochrome) and CGA (for color/graphics).

If you want to run some applications in the monochrome mode, and other applications in the color/graphics mode, use the MODE command to override the power-on setting.

SELECTING IBM PC-COMPATIBLE DISPLAY MODES

You can run all existing IBM Monochrome and Color/Graphics Adapter PC-compatible applications programs in their respective display modes. However, many programs do not set the display mode automatically, so you may have to select the mode.

Note--It is important to remember that accidentally running a program in the wrong mode (causing "garbage" or some other irregularity to appear on the display) harms nothing. In fact, you may need to select a display mode through trial and error to find the correct one for your program.

The following items describe the two situations you may encounter when trying to run an applications program for the first time.

- o If you are running a program that does not set the display mode, and the display is not what you want, you can use the MODE command to change the display mode.
 - o If you are running a program that does not set the display mode, and the display is not what you want, you can use the MODE command to change the display mode.
- Note**--Using the MODE command to change the display mode is not recommended. If you are running a program that does not set the display mode, and the display is not what you want, you can use the MODE command to change the display mode.

Determining the Correct Mode

It's not difficult to determine what mode a program needs. If the application doesn't do it automatically, there are two ways:

- o The documentation for the application program will tell you what mode it needs. If the documentation does not say, then you can try the following:

MODE MONO

If color/graphics is required, enter

MODE CGA

- o During the installation of the application, you may be asked if you have a monochrome or color/graphics display. If you want monochrome, enter

MODE MONO

If you want color/graphics, enter

MODE CGA

1. Press any key. If the screen is test only, enter

MODE MONO

If this display does not look right (or if the application uses graphics), enter

MODE CG80

Note--Although you can also select the correct IBM PC-compatible mode through the SCREEN utility program, normally you would run the utility only to select one of the three high-resolution text modes (available for special applications programs that require special drivers).

Troubleshooting Mode Problems

If you've selected the wrong mode, the screen may show the following symptoms:

Symptom Screen "looks funny."
Some characters don't display or display incorrectly.
Characters that should be underlined are not.
The cursor is missing.

Solution The program is probably written for an IBM PC-compatible monochrome display mode, and you have selected a color/graphics display mode. Enter either the MODE MONO (or SCREEN MONO) command and see if the screen looks normal.

Symptom Screen display, monochrome, is not as tall as the screen.

Solution ANSI.SYS is not installed or is not running. ANSI.SYS or a similar program is available with the PC-DOS 2.0 software.

Symptom Reverse video fields are not reversed.
Characters underlined when they should not be.
The cursor appears in the middle of characters.

Solution Enter

MODE CG80

Symptom "Garbage" (random characters) appears on the screen.

Solution The applications may be trying to use graphics and you have selected monochrome. Enter

MODE CG80

Common Applications and Modes

Table 1-1 lists two common off-the-shelf applications and indicates their respective correct modes.

Note--Many games include graphics and are started up, loading directly from the game diskette. Since you cannot enter any command in this situation, the computer should be "told" to power-up in the color/graphics mode (see "Power-Up Display Mode" in Chapter 2).

Table 3-1 Common Applications Program Modes

Program	Typical Mode	Comments
WordStar	MODE H0V0	MODE C0S0 may be required, depending on how the program was installed.
Lotus 1-2-3	MODE C0S0	Install Lotus 1-2-3 for the color/graphics mode only.

HIGH-RESOLUTION MODES

To make full use of the high-resolution capabilities of the graphics subsystem with IBM PC-compatible applications programs, you need special drivers. In addition, you can create new applications packages based on the Graphics Subsystem's enhanced screen capabilities. See the Programmer's Manual for complete information.

4 UTILITY PROGRAMS

Overview.....

Loading the Utility Programs.....

Running the Utility Programs.....

The CLEAR Utility.....

The SAVED Utility.....

The FONT Utility.....

The SCREEN Utility.....

Memory-Resident Programs.....

Load Commands.....

OVERVIEW

On the utility programs diskette that is included in the subsystem's package, you will find four utility programs. Although your system will run IBM PC-compatible software without these utility programs (after you have installed the display adapter card), you need to load the utility programs into your computer in order to take advantage of the advanced features provided by the display adapter card. The utility programs

- Clear the display
- Turn the screen saver feature on or off
- Select the primary or alternate font
- Select the display mode from a range of choices

Note--Although you can select a display mode with the SCREEN utility, normally you select one of the three standard display modes with the MS-DOS MODE utility commands (MODE MONO, MODE COGO, and MODE CGA).

LOADING THE UTILITY PROGRAMS

First, make a backup copy of the utility program files on a spare diskette. Then, load the programs into your computer by copying all four utility programs into any directory that's convenient (for example, on your hard disk's utility directory, if your computer has a hard disk). When you have done this, you can run the utility programs, whose filenames follow:

CLEAR.EXE	SCREEN.EXE
FONT.EXE	SAVER.EXE

RUNNING THE UTILITY PROGRAMS

This section describes the functions of the four utility programs and explains how to use them.

Note--If you make an error in the command line or the prompt, you

can use the **Ctrl+C** key to stop the program.

When this happens, simply retype the command and press the **Enter** or **RETURN** key.

The CLEAR Utility

Purpose The CLEAR utility clears the entire screen, including its line-and-column configuration. Pressing the **Ctrl+C** command clears only the first 25 lines and 80 columns. If you have selected a 50-line or 100-line display, you must run this utility.

Note--CLEAR also returns the cursor to the upper-left corner of the screen and displays the operating system prompt.

Execution Enter (in upper- or lowercase characters)

clear

The system clears the entire screen, homes the cursor, and displays the operating system prompt.

The Saver Utility

Purpose The Saver utility is a memory-resident program (see "Memory-Resident Programs" in this chapter). This utility prolongs the life of the screen's phosphor by turning off the display after the computer has been inactive for a specified number of minutes (15 minutes is the default setting).

Caution--Interactions between memory-resident programs can occur. If this happens, only one of the programs can be used.

When Saver turns off the display, no data is lost. You can restore the display by pressing any key. The SHIFT key is best because it doesn't affect your data.

If you set the Saver utility to OFF, the screen continues to display data indefinitely.

Note--If you fail to enter a command option, the system displays

Invalid parameter. Type 'SAVER HELP' for help.

The following examples show you how to execute four commands with the Saver utility.

Execution To display the help screen, enter

saver help

The system displays

SAVER Version 12-02-87

This screen saver utility was added to the IBM High Resolution Display screen. With the screen saver feature on, the display will be turned off if the computer has not been used for a specified number of minutes. To turn the display on again, press any Shift key.

Use the following commands:

SAVER HELP	(display this help message)
SAVER STATUS	(display current screen saver status)
SAVER OFF	(turn screen saver off)
SAVER ON	(turn screen saver on)
SAVER nnnn.nn	(turn screen saver on, add set saver time to nnnn.nn minutes)

Note--The utility load command Saver LOAD does not appear on the help screen. (See "Load Commands" in this chapter.)

Execution To find out the status of the saver utility, enter

saver status

The system displays

Screen saver is now on.
The display will be turned off after 10 minutes of inactivity.

The other Saver commands display similar messages.

Execution To set the screen saver to turn off after 12.5 minutes (12 minutes and 30 seconds), enter

safer 12.5

The system displays

Screen saver is now on.
The display will be turned off after 12.5
minutes of inactivity.

Execution To set the screen saver to turn off after 2 minutes, enter

safer 2

The system displays

Screen saver is now on.
The display will be turned off after 2
minutes of inactivity.

The FONT Utility

Purpose The FONT utility selects either the primary font or an alternate font, if one has been created for your system (as explained in the *Programmer's Manual*). You can select only one font for the screen at any time.

If your system doesn't contain an alternate font, the screen always displays the default font.

The following shows you how to execute three commands with the FONT utility.

Execution 1 select = font, 0000

Font or font help

The system displays

This font selection utility is for use with the
High Resolution Display Adapter. It allows selection
of two fonts for the alphanumeric display.

Use the following commands:

FONT 0 (the default font)
FONT 1 (the alternate font)

If you enter

font 0

the system displays

Font 0 selected.

If you enter

font 1

the system displays

Font 1 selected.

The SCREEN Utility

Purpose The SCREEN utility is memory-resident program (see "Memory-Resident Programs" in this chapter). With this utility, you can select the display mode for your application programs, as described in "Standard IBM PC-Compatible Display Modes" in Chapter 1. The following list summarizes some things you should keep in mind when running the SCREEN utility:

- o Normally you select one of the three standard display modes with the MS-DOS MODE utility commands (MODE MONO, MODE CO40, and MODE CO80). Although the SCREEN utility program allows you to make the same selection, you would usually run this utility only to select one of the high-resolution text (alphanumeric) modes available for special application programs that require special drivers. (See the Programmer's Manual.)
- o IBM PC-compatible programs will run in the high-resolution modes only if adapted by a programmer or software vendor. (See "High-Resolution Modes" in this Chapter 3.)
- o Accidentally running a program in the wrong mode (causing "garbage" or some other irregularity to appear on the display) harms nothing. In fact, you may need to try display modes through trial and error to find the correct one for your program.
- o Nearly all games will automatically select their own display graphic modes. You probably need to select nothing.

Caution--The SCREEN utility will not work with ANSI.SYS installed.

The following examples show how to use the commands with the SCREEN utility:

Execution To see what choices are available, type

screen help

Note--If don't enter a parameter, the SCREEN utility

Invalid parameter. Type 'SCREEN HELP' for help.

The system displays

SCREEN Version 12-02-85

This program selects a display mode for the High Resolution Display.

These commands display information:

SCREEN HELP (display this help message)
SCREEN STATUS (display currently selected mode)

These commands select PC screen modes for standard software.

SCREEN MONO (80 col x 25 lines monochrome mode)
SCREEN CO80 (80 col x 25 lines color/graphics mode)
SCREEN CO40 (40 col x 25 lines color/graphics mode)

These commands select high-resolution modes for special software:

SCREEN 80 x 25 (80 columns and 25 lines)
SCREEN 80 x 50 (80 columns and 50 lines)
SCREEN 160 x 25 (160 columns and 25 lines)
SCREEN 160 x 50 (160 columns and 50 lines)
SCREEN 25 (25 lines, don't change columns)
SCREEN 50 (50 lines, don't change columns)
SCREEN 80 (80 columns, don't change lines)
SCREEN 160 (160 columns, don't change lines)

Note--The utility **LOAD** command **SCREEN LOAD** does not appear on the help screen. (See "Load Commands" in this chapter.)

Caution--Interactions between memory-resident programs can occur. If this happens, only one of the programs can be used. (See "Memory-Resident Programs" in this chapter.)

Execution To run an application that's written for a monochrome adapter, enter

```
screen moad
```

The system displays

```
80 x 25 Monochrome mode selected.
```

Execution To run an application program that's written for a color/graphics adapter with 80 characters per line, enter

```
screen coad
```

Note--Be careful to distinguish the letter **C** from the number **0**.

The system displays

```
80 x 25 color/graphics mode selected.
```

The other options display similar messages.

MEMORY-RESIDENT PROGRAMS

When you enter commands for memory-resident utilities simply pressing the **ENTER** key loads the command. In contrast, memory-resident programs are loaded into your system, where they perform tasks. For example, the **SAVER** utility is loaded into preparation to turn off the screen saver.

Many programs are memory-resident, including organizer programs, text editors, and word processing programs. By their nature, memory-resident programs sometimes interact and interfere with each other. This may arise if you have more than one program loaded in your system.

The **SAVER** and **SCREEN** utilities will not work in memory interaction with other memory-resident programs if they are loaded last (see "Load Commands" below).

Caution--If your memory-resident programs interfere with each other, the programs can be used.

LOAD COMMANDS

Two utility load commands, **SAVER LOAD** and **SCREEN LOAD**, appear on their respective help screens.

In order to avoid memory-resident interaction, load the **SAVER** and **SCREEN** utilities last into your system using the **SAVER LOAD** and **SCREEN LOAD** commands.

Caution--If your memory-resident programs interfere with each other, the programs can be used.

APPENDIX A SPECIFICATIONS

OPERATING MODES

Alphanumeric

Character Sets: Hardware generated.
Two sets of 256 codes (ASCII and EBCDIC).
Software switchable between sets.

Mode Switching: Via software

Modes:	<u>IBM monochrome</u>	80 columns, 24 lines
	<u>IBM color</u>	80 columns, 24 lines
	<u>Native</u>	80 columns, 24 lines 160 columns, 12 lines 160 columns, 6 lines

Formats:	<u>Character</u>	<u>Screen</u>
	16 x 12 pixels	80 columns x 24 lines
	32 x 12 pixels	40 columns x 24 lines

Graphics

Type: Bit mapped

Mode Switch/Type: Automatic

Modes:

<u>IBM color</u>	320 x 200 (4 x 4 pixels/graphic dot)
	640 x 400 (2 x 4 pixels/graphic dot)
<u>Native high-resolution</u>	640 x 400 (2 x 2 pixels/graphic dot)
	1280 x 400 (1 x 2 pixels/graphic dot)
	1280 x 800 (1 pixel/graphic dot)

Cursor: Blink, reverse, underline, normal, high and low intensity

MONITOR

Dimensions	Width	Height	Depth
	19.37 in (365mm)	13.58 in (345mm)	11.89 in (302mm)

Weight: Net 24.9 lb (11.3 kg)
Shipping 27.9 lb (12.7 kg)

Movement: Tilt +25 to -6.5 degrees
Swivel ± 125 degrees

CRT

Display: Diagonal 15 in (381mm)
Horizontal 10.1 in (256mm)
Vertical 7.6 in (192mm)

Glass: Dark bonglare

Processor: 486/33MHz

Horizontal Scan Rate: 30 kHz

Vertical Refresh: 60 Hz (18.75 kHz)

Video Bandwidth: 50 MHz

DISPLAY ADAPTER CARD

Type: Full size 16-bit VGA card

Memory: 128K dynamic RAM

Connector: 9-pin industry standard

Character Generator: Two full character sets (256 characters each)

CABLES: 6-foot power cord
Video cable

ENVIRONMENTAL REQUIREMENTS

Temperature: Ambient 100 to 150 °C
(500 to 950 °F)

Nonoperating -300 to 600 °C
(-500 to 1400 °F)

Humidity: 20% to 80% (noncondensing)

Altitude: Operating 0 to 10,000 ft
Nonoperating 0 to 40,000 ft

POWER

Line Voltage: Standard 100-240 VAC, 50 Hz
and Frequency: Optional 220 VAC, 50 Hz

Power Consumption: 50 Watts

Fuses: 3.0 amp, 250 volt, Fast blow

REGULATORY APPROVALS

EMI
FCC Class A
UL
CE

OPTION

WT-1100-30 Pedestal Base

INDEX

A

Adapter with Line Converter
adapter, 1-2

Alphanumeric display
character set, 1-1
column width, 1-1
lines, 1-1

Altitude requirements, 1-1

ANSI X3B1, 3-5

Applications programs
common, 3-5
first use, 3-2
running, 3-2
setting modes, 3-5

B

Brightness, 2-4, 2-5

Built-in display oscillators,
2-3

C

Cables, 2-5, 2-6, A-1

CLEAR utility, 4-3

Computer
built-in display
circuitry, 2-3
jumper settings, 2-3
power-up, 2-5
serial ports, 1-2
SETUP utility, 2-5

D

Display, 1-1
display, 1-1
display, 1-1
display, 1-1
display, 1-1
display, 1-1
display, 1-1

E

Environmental requirements, 1-1
Environmental requirements, 1-1
Environmental requirements, 1-1
Environmental requirements, 1-1
Environmental requirements, 1-1
Environmental requirements, 1-1
Environmental requirements, 1-1

F

Fuses, 3-2

G

Grounding, 1-1

Font style, 4-6
 Fonts, 1-3
 Frequency, 4-4
 Page, 4-4, 2-9

- Games, 1-4, 3-5
- Graphics dot, 1-4
- Graphics subsystem
 - character sets, A-1
 - characteristic summary, 1-7
 - description, 1-2
 - environmental requirements, A-3
 - features, 1-3
 - installation, 2-2
 - mode switching, A-1, A-2
 - operating modes, A-1, A-2
 - operation, 2-7
 - option, A-4
 - power, A-4
 - regulatory approvals, A-4
 - screen attributes, A-2
 - specifications, A-1, A-2
 - troubleshooting, 2-4
 - unpacking, 2-2
 - with games, 3-5
- Graphics subsystem display compared to standard, 1-2
 - 1-3
 - superior resolution, 1-2, 1-3
- Graphics subsystem monitor
 - clearance, 2-5
 - dimensions, A-2

```

specifications model:1
  (continued)
  installation, 3-5, 3-6
  movement, A-2
  specifications, A-2
  tilting and turning, 3-6,
    3-7
  weight, A-2

```


- High-resolution color/graphics display, 1-3
- custom packages, 3-6
- display modes, 1-6
- modes, 3-6
- pixels/character cell, 1-4, 1-5, 1-6
- pixels/graphic dot, 1-4, 1-5, 1-6
- hardware requirements, A-3

T

- compatibility, 1-3
- compatible display modes, 1-3, 1-6
- compatible modes, 3-2
- installation, 3-2

- Jumper settings
 - for one monitor, 2-3
 - for more than one monitor, 2-3
- Jumper location, 2-4

1

LOAD N=0


```
Memory-reserved program
Intermittent, 2-4, 9-
4-11
SASEN utility, 4-4, 4-5
SCREEN utility, 4-0, 4-1
Mode switching, 4-6
Monochrome display, 4-1
MS-DOS, 2-4
MS-DOS MODE commands, 4-7,
4-9, 4-3, 4-8
```


ON/OFF switch, 2-6, 2-7, 2-8
Operator controls
brightness thumbwheel,
2-6, 2-7, 2-8
ON/OFF switch, 2-6, 2-7,
2-8

E

- Power consumption, A-4
- requirements, A-4
- Power cord, 2-5, 2-7, 2-8, A-3
- Power-up display mode
 - configuring, 2-5
 - setting switches, 2-5

 Springer

Regulatory approvals. A-4

- quality programs 129, 130
- cleanup, 4-3
- font, 4-6
- load commands 129, 130
 - loading, 4-3
 - overview, 4-2
 - running, 4-3
- SAVEP, 1-5, 4-4
- SCREEN, 5-7, 5-8, 5-9, 5-10

*Programmer's
Manual*

USER GUIDE

The graphics adapter's software enables the user to select and color/graphics modes, resolution graphics modes, and information you need to write a custom application that emulates the IBM modes or other selections of the graphics resolution modes.

This guide is a companion to the user's manual, which describes how to install the display adapter and lists the supported special commands.

TABLE OF CONTENTS

1 PROGRAMMING INTRODUCTION

Display Modes.....	1
Compatible Devices.....	1
I/O Ports.....	1
Display Memory.....	1
Pixel Displays.....	1

2 PROGRAMMING NATIVE HIGH-RESOLUTION MODES

Selecting a Native High-Resolution Graphics Mode.....	2
Programming Native 800 X 600 Mode.....	2
or Gray Scale 800 X 600 Mode.....	2
Programming Native 800 X 400 Mode.....	2
or Gray Scale 800 X 400 Mode.....	2
Programming Native 640 X 400 Mode.....	2
or Gray Scale 640 X 400 Mode.....	2
Displaying Different Pages.....	2

3 PROGRAMMING IBM MONOCHROME EMULATION MODE

Selecting This Mode.....	3
Writing to CRT Control Port 1.....	3
Initializing the 6845 CRT Controller Registers.....	3
Programming Display Memory.....	3

4 PROGRAMMING IBM COLOR/GRAPHICS EMULATION MODES

Selecting These Modes.....	4-2
Writing to the Mode Control Register.....	4-2
Initializing CRT Controller Registers.....	4-5
Programming Display Memory.....	4-6

5 ADDRESSING THE EXTENDED BIOS..... 5-1

6 CUSTOMIZING THE ROM CHARACTER SETS

Standard Character Set.....	6-2
Custom Character Sets.....	6-2

INDEX..... 1-1

LIST OF FIGURES

2-1 Native Control Port (DSM (Write Only) - Native Modes.....	2-1
2-2 CRT Control Port (DSM (Write Only) - Monochrome Emulation.....	2-4
2-3 CRT Status Port (DSM (Read Only) - Monochrome Emulation.....	2-4
2-4 Mode Control Register (DSM (Write Only) - Color/Graphics Emulation.....	4-1
4-1 Status Register (DSM (Read Only) - Color/Graphics Emulation.....	4-4

LIST OF TABLES

1-1 Available Display Modes.....	1-1
1-2 I/O Port Map.....	1-2
1-3 Memory Map.....	1-3
1-4 Bit Scheme for Black and White Modes.....	1-4
1-5 Bit Scheme for Gray Scale Modes.....	1-5
2-1 Native High Resolution Graphics Modes.....	2-1
2-2 Native Screen Start Values (Base 10) - For All Native Modes.....	2-2
2-3 Native Control Port Values - Black and White 1280 x 800, Gray Scale 640 x 400 Modes.....	2-3
2-4 Native Screen Start Values (Base 10) - Black and White 1280 x 800, Gray Scale 640 x 400 Modes.....	2-4
2-5 Memory Scheme - Black and White 1280 x 800, Gray Scale 640 x 400 Modes.....	2-5
2-6 Native Control Port Values - Black and White 1280 x 400, Gray Scale 640 x 400 Modes.....	2-6
2-7 Native Screen Start Values (Base 10) - Black and White 1280 x 400, Gray Scale 640 x 400 Modes.....	2-7
2-8 Memory Scheme - Black and White 1280 x 400, Gray Scale 640 x 400 Modes.....	2-8
2-9 Native Control Port Values - Black and White 640 x 400, Gray Scale 320 x 400 Modes.....	2-9
2-10 Native Screen Start Values (Base 10) - Black and White 640 x 400, Gray Scale 320 x 400 Modes.....	2-10
2-11 Memory Scheme - Black and White 640 x 400, Gray Scale 320 x 400 Modes.....	2-11
2-12 Display Pages - Black and White 640 x 400, Gray Scale 320 x 400 Modes.....	2-12
3-1 CRT Control Port 1 - Monochrome Emulation Values.....	3-1
3-2 6845 Registers - Monochrome Emulation.....	3-2
3-3 Character Attributes - Monochrome Emulation.....	3-3

DISPLAY MODES

The High-Resolution Display Adapter can operate in a number of different display modes. The Display Adapter is compatible with both the IBM Monochrome and Color/Graphics Display Adapters, and provides monochrome and color/graphics emulation modes to work with most applications for the IBM PC, IBM XT, IBM AT, or compatibles.

In addition, the adapter works with the monitor to provide six native high-resolution graphics modes. You can write programs for those modes which create exceptionally detailed displays.

The monitor runs at all times at 1280 x 800 video dots. Each pixel is composed of one or more video dots. The lower resolution modes are done internally by doubling or quadrupling pixels.

A summary of the available display modes is given in Table 1-1.

Table 1-1 Available Display Modes

Display Mode	Alpha Cols x Rows	Graphics HORIZ x VERT Pixels
IBM Emulation Modes		
IBM Monochrome	80 x 25	
IBM Color/Graphics	40 x 25	
IBM Color/Graphics	80 x 25	
IBM Color/Graphics		320 x 200
IBM Color/Graphics		640 x 200

Table 1-1 Continued

Display Mode	Alpha Cols x Rows	Graphics HORIZ x VERT Pixels
Native Graphic Modes		
Gray Scale		1280 x 800
Gray Scale		1280 x 800
Gray Scale		1280 x 800
Black and White		1280 x 800
Black and White		1280 x 800
Black and White		1280 x 800

Native Alpha Modes Supported By Extended Bios

Black and White	80 x 25
Black and White	80 x 50
Black and White	160 x 25
Black and White	160 x 50

A program can switch from one display mode to another at any time; the adapter operates in the mode specified by the program.

COMPATIBLE DEVICES

Mice, digitizing pads, or other similar devices will work with the adapter if they are hooked up correctly to a standard serial port (a serial port is not included on the adapter). IBM devices, however, are not supported.

I/O PORTS

The display adapter has three ranges of I/O ports: IBM monochrome emulation ports, IBM color/graphics emulation ports, and native high-resolution ports. The addresses of these ports are listed in Table 1-2.

Table 1-2 I/O Port Map

I/O Address	Function	Type
180H-18FH	IBM Monochrome Ports	Read/Write
100H-10FH	IBM Color/Graphics Ports	Read/Write
300H-30FH	Native High Resolution Ports	Write Only

DISPLAY MEMORY

The display adapter responds to any of the three ranges of memory addresses shown in Table 1-3.

Table 1-3 Memory Map

Memory Address	Function
A70004 - AFFFFF	Native High-Resolution Display Memory
B00000 - B1FFFF	IBM Monochrome Display Memory
B80000 - BFFFFF	IBM Color/Graphics Display Memory

The IBM memory ranges are always active (unless disabled with jumpers - see the User's Guide), but the native memory range is active only when one of the native modes is selected.

Note--The adapter neither initializes nor preserves display memory when changing display modes. Therefore, your program must reinitialize the display memory every time it selects a new mode.

Also note that the adapter's internal display memory is shared with the display adapter. Therefore, the adapter's internal display memory is not available for use by the operating system. The adapter's internal display memory is used for the native display mode.

PIXEL DISPLAYS

When the display adapter is in a graphics mode, the display adapter's bit mask can set any pixel to on or off. Table 1-4 shows how the bit mask is used to set the pixel. The bit mask is displayed as eight hexadecimal digits, with the most significant bit appearing on the left and the least significant bit on the right.

Table 1-4 Bit Scheme for Black and White Modes

Bit Mask	Pixel Displayed
x00000000	Left-most
0x00000000	
00x000000	
000x00000	
0000x0000	
00000x000	
000000x00	
0000000x0	Right-most
00000000x	

where x = 0, pixel is off (black)
1, pixel is normal intensity (white)

When the display adapter is in a graphics mode, the display adapter's bit mask is used to set the pixel. The bit mask is displayed as eight hexadecimal digits, with the most significant bit appearing on the left and the least significant bit on the right.

getbit(x) shows how the mask bit of word x is (0=gray scale) modes are displayed as 00000000, with the most significant bit showing 0=70, 1=80, the least significant bit on the right.

Table 1-5 Bit Scheme for Gray Scale Modes

Bit Mask	Pixel Displayed
xx000000	Left-most
00xx0000	
xx00	
0000xx00	Right-most

where xx = 00, pixel is off (black)
 01, pixel is half-intensity white
 10, pixel is normal intensity white
 11, pixel is high-intensity white

2 PROGRAMMING NATIVE HIGH-RESOLUTION MODES

Selecting a Native High-Resolution Mode
 Writing to the Native C
 Initializing the Native C

Programming Native S/W 1280 x 800 Mode
 or Gray Scale 640 x 800 Mode.....
 The Modes.....
 The Memory Scheme.....

Programming Native S/W 1280 x 400 Mode
 or Gray Scale 640 x 400 Mode.....
 The Modes.....
 The Memory Scheme.....

Programming Native S/W 640 x 400 Mode
 or Gray Scale 320 x 400 Mode.....
 The Modes.....
 The Memory Scheme.....

Displaying Different Pages.....

SELECTING A NATIVE HIGH-RESOLUTION GRAPHICS MODE

The display adapter supports six native high-resolution graphics modes, as follows:

Black and White	Gray Scale
1280 x 800	640 x 800
1280 x 400	640 x 400
640 x 400	320 x 400

These modes cannot be disabled through jumpers.

You select and initialize one of the high-resolution graphics modes by instructing your program to:

- o Write a particular value to the Native Control Port.
- o Initialize the Native Screen Start Low and High Ports.

Table 2-1 shows the I/O Map for these ports.

Table 2-1 Native High-Resolution Graphics Modes I/O Map

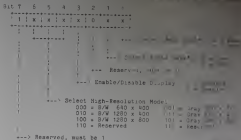
Address	Function	Type
300H	Native Screen Start Low Port	Write Only
30EH	Native Screen Start High Port	Write Only
30FH	Native Control Port	Write Only

The following sections provide the values and the details for programming these ports.

Writing to the Native Control Port

The Native Control Port initializes the native high-resolution graphics mode and display, as shown in Figure 2-1.

Figure 2-1 Native Control Port 30FH (in 300H) I/O Map



* The Select Bank switches are only valid in B/W 1280 x 800 and Gray Scale 640 x 800 modes. The bank selection is described more detail in the section describing these modes in this chapter.

When disabling the display, be certain to specify the correct display mode to ensure that all enable display memory is refreshed in the dynamic RAMs.

Initializing the Native Screen Start Ports

The Native Screen Start Ports located at 3DD8 (low) and 3DE8 (high) determine which scan line is displayed first, and can be used to scroll the display.

When you select the mode, you should initialize these ports to zero. Subsequently, if you want your program to scroll the screen, you can write a value to the low and high ports. Table 2-2 shows how to compute the value to be written from either the scan line number or the memory address.

Table 2-2 Native Screen Start Values (Base 10) For All Native Modes

B/W 1280 x 800 or Gray Scale 640 x 800

Value = ((Scan Line) div 2) * 40

or

Value = Address div 4 * 40

B/W 1280 x 400 or Gray Scale 640 x 400

Value = Scan Line * 40

or

Value = Address div 2

B 640 x 400 or Gray Scale 320 x 400

Value = Scan Line * 20

or

Value = Address div 4

You must use separate operations to write the 16-bit values to the low and high ports of the Native Screen Start Ports.

Note that the display can also be disabled in the 1280 x 800 or Gray Scale 640 x 800 modes.

PROGRAMMING NATIVE B/W 1280 X 800 MODE OR GRAY SCALE 640 X 800 MODE

The Modes

In these modes, all of the 128K bytes of display memory can be used to yield either a black and white display with a resolution of 1280 horizontal and 800 vertical pixels, or a gray scale display with a resolution of 640 horizontal and 800 vertical pixels. To select these modes, you write one of the values in Table 2-3 to the native control port (as explained in *Initializing the Native Control Port*).

Table 2-3 Native Control Port Values - Black and White 1280 x 800, Gray Scale 640 x 800 Modes

Hex	Binary	Function
C5	11001000	Enable Display B/W 1280 x 800 Mode, Read/Write Even Bank
C6	11001011	Enable Display B/W 1280 x 800 Mode, Read/Write Odd Bank
C0	11000000	Disable Display B/W 1280 x 800 Mode, Read/Write Even Bank
D8	11011000	Enable Display Gray Scale 640 x 800 Mode, Read/Write Even Bank
D9	11011011	Enable Display Gray Scale 640 x 800 Mode, Read/Write Odd Bank
D0	11010000	Disable Display Gray 640 x 800 Mode, Read/Write Even Bank

When you enter this mode, you should first initialize both the native low screen start port (at 3020) and the native high screen start port (at 3028) to zero. Subsequently, if you want to use native screen start bits to scroll the screen, you can write values to them. Compute the values for the ports as shown in Table 2-4.

Table 2-4 Native Screen Start Values (Base 10) - Black and White 1280 x 800, Gray Scale 640 x 400 Modes

Value = ((Scan Line) div 2) * 40

or

Value = Address div 4 * 40

The Memory Scheme

Since the memory address space for the native display modes is only 64K bytes from A0000H through AFFFFH, the display memory for these modes is divided into two banks. The even bank contains the even scan lines, and the odd bank contains the odd scan lines. There are separate bank select bits in the native control port for reading and writing to make screen-to-screen copying more efficient.

Table 2-5 shows the memory scheme for these modes. Each scan line uses 140 (A0 hex) bytes of display memory. The first byte of each scan line is displayed on the left, and the last byte is displayed on the right.

Table 2-5 Memory Scheme - Black and White 1280 x 800, Gray Scale 640 x 400 Modes

Scan Line	Bank	First Byte	Last Byte
0	0	A0000H	
1	1	A0000H	
2	0	A0000H	
3	1	A0000H	
4	0	A0000H	
5	1	A0000H	
...
796	0	AFFFFH	
797	1	AFFFFH	
798	0	AFFFFH	
799	1	AFFFFH	

PROGRAMMING NATIVE B/W 1280 X 400 MODE OR GRAY SCALE 640 X 400 MODE

The Modes

These modes provide high-resolution graphics and are implemented in a single bank of memory. You select these modes by writing the values in Table 2-6 to the native control port.

Table 2-6 Native Control Port Values - Black and White 1280 x 400, Gray Scale 640 x 400 Modes

Hex	Binary	Function
13	10101000	Enable Display B/W 1280 x 400 Mode
10	10100000	Disable Display B/W 1280 x 400 Mode
38	10111000	Enable Display Gray Scale 640 x 400 Mode
20	10110000	Disable Display Gray Scale 640 x 400 Mode

When you enter this mode, you should also initialize both the native low screen start port (at 300H) and the native high screen start port (at 30EH) to zero. Subsequently, if you want to use those screen start ports to scroll the screen, you can write values to them. Compute the values for the ports as shown in Table 2-7.

Table 2-7 Native Screen Start Values (Base 10) - Black and White 1280 x 400, Gray Scale 640 x 400 Modes

Value = Scan Line * 80
or
Value = Address div 4

The Memory Scheme

Since only 64K bytes of display memory are needed for these modes, the display memory is contained in a single bank. There are 160 (AD Hex) bytes of memory for each scan line. The memory scheme for these modes is shown in Table 2-8.

Table 2-8 Memory Scheme - Black and White 1280 x 400, Gray Scale 640 x 400 Modes

Scan Line	Bank	First Byte	Last Byte
0	0	A0000H	A00FFH
1	0	A00A0H	A013FH
...
398	0	AF960H	AF95FH
399	0	AF960H	AF9FFH

PROGRAMMING NATIVE B/W 640 x 400 MODE OR GRAY SCALE 640 x 400 MODE

The Modes

These modes support two separate pages. A display controller can be used for animation or fast screen scrolling. To use these modes by writing the values in Table 2-9 to the native control port.

Table 2-9 Native Control Port Values - Black and White 640 x 400, Gray Scale 320 x 400 Modes

Hex Binary Function

80	10001000	Enable Display B/W 640 x 400 Mode
80	10000000	Disable Display B/W 640 x 400 Mode
98	10011000	Enable Display Gray Scale 640 x 400 Mode
98	10010000	Disable Display Gray Scale 640 x 400 Mode

When you enter this mode, you should also initialize the native low screen start port (at 300H) and the native high screen start port (at 30EH) to zero. Subsequently, if you want to use those screen start ports to scroll the screen, you can write values to them. Compute the values for the ports as shown in Table 2-10.

Table 2-10 Native Screen Start Values (Base 10) - Black and White 640 x 400, Gray Scale 320 x 400 Modes

Value = scan line * 20
or
Value = address div 4

The Memory Scheme

Since these modes require only 32K bytes of display memory, the display memory is completely contained in a single bank.

There are 80 (50 Max) bytes of memory for each scan line. The memory scheme for these modes is shown in Table 2-11.

Table 2-11 Memory Scheme - Black and White 640 x 400, Gray Scale 320 x 400 Modes

Scan Line	Bank	First Byte	Last Byte
0	0	A0000H	A004FH
1	0	A0050H	A009FH
2	0	A00A0H	A00EFH
...
799	0	A7C50H	A7C9FH
800	0	A7CB0H	A7CFFH

DISPLAYING DIFFERENT PAGES

These modes support two display pages. Both pages are located in the same bank at different addresses. Table 2-12 shows how to write to the native screen start registers to display one of the pages.

Table 2-12 Display Pages - Black and White 640 x 400, Gray Scale 320 x 400 Modes

Memory Range	Bank	Start High	Start Low
A0000H - A7CFFH	0	00	00
A8000H - AF0FFH	0	20	00

3 PROGRAMMING IBM MONITOR/EMULATION MODE

Selecting This Mode.....

Writing to CRT Control Port 1.....

Initializing the 6845 CRT Controller Registers.....

Programming Display Memory.....

SELECTING THIS MODE

When this mode is selected, the display adapter emulates the IBM Monochrome Display Adapter.

Note--If the MOND jumper is set to the OFF position, the card will not respond to any monochrome I/O or memory accesses.

The adapter also supports four memory pages of 80 x 25 characters, an enhancement over the IBM Monochrome Display Adapter, which supports only a single memory page.

Note--If you write a program which uses more than one page of memory, the program will not run on a standard IBM monochrome display.

You select this mode by

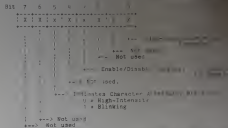
- o Writing to CRT Control Port 1.
- o Initializing the 6845 CRT Controller Registers 30-35.

You may write to these ports in any order.

WRITING TO CRT CONTROL PORT 1

CRT Control Port 1, located at address 3B8H, selects IBM monochrome emulation mode and enables or disables the display, as shown in Figure 3-1.

Figure 3-1 CRT Control Port 1 - IBM Monochrome Emulation



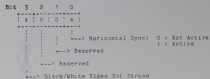
To select the mode and enable or disable the display, use one of the values in Table 3-1 to CRT Control Port 1.

Table 3-1 CRT Control Port 1 - Monochrome Emulation Values

Hex	Binary	Function
29	00101001	Select 80 x 25 AlphaNumeric
21	00100001	Disable Display

You may also check display controller status by reading the CRT status port at 3BAH, as shown in Figure 3-2.

Figure 3-2 CRT Status Port IDAN (Read Only) - Synchronous Emulation



INITIALIZING THE 6845 CNT CONTROLLER REGISTERS

To ensure that monochrome emulation mode operates normally, you must initialize registers 80-8F5 of the 6845 CRT Controller. Initialize the registers by

- ```

6. Writing the register number to the 6845 Index Register (3040).
7. Writing the register value to the 6845 Data Register (3080).

```

Table 3-2 shows the values to properly initialize these registers.

Table 4-2 6455 Registers - Recommended Load/Store

| Register | Function                 | Type       |
|----------|--------------------------|------------|
| R0       | Horizontal Total         | Write Only |
| R1       | Horizontal Displayed     | Write Only |
| R2       | Horizontal Sync Position | Write Only |
| R3       | Horizontal Sync Width    | Write Only |
| R4       | Vertical Total           | Write Only |
| R5       | Vertical Total Adjust    | Write Only |
| R6       | Vertical Displayed       | Write Only |
| R7       | Vertical Sync Position   | Write Only |
| R8       | Interlace Mode           | Write Only |
| R9       | Maximum Scan Line        | Write Only |
| R10      | Cursor Start             | Write Only |
| R11      | Cursor End               | Write Only |
| R12      | Start Address (H)        | Read/Write |
| R13      | Start Address (L)        | Read/Write |
| R14      | Cursor (H)               | Read/Write |
| R15      | Cursor (L)               | Read/Write |

## PROGRAMMING DISPLAY HUBCHIT

In IBM Monochrome Emulation Mode, there are 16K bytes of memory located at addresses 80000H-83FFFH. This display supports four screens organized as 80 columns by 25 rows. Each character is represented by one byte for the character followed by one byte for the attribute, with the character at even addresses and the attributes at odd addresses.

The Display Adapter supports 256 different characters -- all in ROM. The attribute for each character is contained in the following table. The attributes are shown in Table 1.

Table 3-3 Character Attributes - Monochrome Emulation

| Hex | Binary   | Attributes                          |
|-----|----------|-------------------------------------|
| 00  | 00000000 | Non-Display                         |
| 01  | 00000001 | Underline                           |
| 02  | 00000111 | Normal                              |
| 03  | 01110000 | Reverse Video                       |
| 04  | 00001001 | Underline, High Intensity           |
| 05  | 10000001 | Underline, Blinking                 |
| 06  | 10001001 | Underline, High Intensity, Blinking |
| 07  | 00001111 | Normal, High Intensity              |
| 08  | 10000111 | Normal, Blinking                    |
| 09  | 10001111 | Normal, High Intensity, Blinking    |
| 0A  | 11110000 | Reverse Video, Blinking             |

-- monochrome display memory can always be read or written (unless disabled by the MCMD jumper), even while the native display adapter is in another mode. Unlike I/O ports, however, the act of reading or writing display memory does not change the state of the screen. This allows programs to clear display memory before reprogramming the I/O registers for a new display mode.

**Caution**--The same physical memory is used for all of the modes of the display adapter. Therefore, do not write to color/graphics display memory while in monochrome emulation mode, unless you immediately reprogram the I/O registers for the new display mode.

#### 4 PROGRAMMING IBM COLOR/GRAPHICS EMULATION MODES

Selecting These Modes.....

Writing to the Mode Control Register .....

Initializing the 6845 CRT Controller Registers .....

Programming the Display Memory...

Alphanumeric Modes.....

Graphics Modes.....

## SELECTING THESE MODES

When any of these modes are selected, the display adapter emulates the IBM Color/Graphics Display Adapter.

Note--If the COLOR jumper on the display adapter is set to the OFF position, the monitor will not respond to any color/graphics I/O or memory accesses.

You select one of these color/graphics modes by instructing your program to

1. Write to the Mode Control Register of the color/graphics I/O area.
2. Initialize Registers 80-8F of the 6845 CRT Controller.

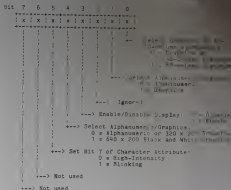
You may write to these ports in any order. The details of these write operations are detailed in the following sections.

Caution--If a program reads or writes color/graphics registers while in the monochrome or native modes, the screen is left in an undefined state until the color/graphics registers have been completely re-initialized.

## WRITING TO THE MODE CONTROL REGISTER

The Mode Control Register, located at address 3D4H, selects the IBM color/graphics emulation mode and enables or disables the display, as shown in Figure 4-1.

Figure 4-1 Mode Control Register 105H (Write Only) - Color/Graphics Emulation



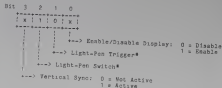
To select the mode and enable or disable the display, you write one of the values in Table 4-1 to the Mode Control Register.

Table 4-1 Mode Control Register - Color/Graphics Emulation Values

| Hex | Binary   | Function                             |
|-----|----------|--------------------------------------|
| 2C  | 00101000 | Select 40 x 25 Alphanumeric          |
| 2A  | 00100100 | Disable Display 40 x 25 Alphanumeric |
| 2D  | 00101101 | Select 80 x 25 Alphanumeric          |
| 25  | 00100101 | Disable Display 80 x 25 Alphanumeric |
| 0E  | 00001110 | Select 320 x 200 Graphics            |
| 06  | 00000110 | Disable Display 320 x 200 Graphics   |
| 1E  | 00011110 | Select 640 x 200 Graphics            |
| 16  | 00010110 | Disable Display 640 x 200 Graphics   |

You may also check the status of the display controller by reading the CRT status port at 3DAH, as shown in Figure 4-2.

Figure 4-2 Status Register 3DAH (Read Only) - Color/Graphics Emulation



\*Since a light-pen is not supported, bits 1 and 2 of the Status Register are always constant.

#### INITIALIZING THE 6845 CRT CONTROLLER REGISTERS

To ensure that color/graphics emulation is properly initialized, you must initialize registers 0 through 17. Initialize the registers by:

1. Writing the register number (3DAH) to the data bus.
2. Writing the register value to the data bus.

Table 4-2 shows the values to properly initialize the registers.

Table 4-2 6845 Registers - Color/Graphics Emulation

| Reg. | Function                 | Type       | 40x25 Alpha | 80x25 Alpha | Graphics Modes |
|------|--------------------------|------------|-------------|-------------|----------------|
| R0   | Horizontal Total         | Write Only | 30H         | 71H         | 10H            |
| R1   | Horizontal Displayed     | Write Only | 28H         | 50H         | 0AH            |
| R2   | Horizontal Sync Position | Write Only | 20H         | 5AH         | 00H            |
| R3   | Horizontal Sync Width    | Write Only | 0AH         | 0AH         | 0AH            |
| R4   | Vertical Total           | Write Only | 1FH         | 1FH         | 00H            |
| R5   | Vertical Total Adjust    | Write Only | 05H         | 06H         | 00H            |
| R6   | Vertical Displayed       | Write Only | 19H         | 15H         | 04H            |
| R7   | Vertical Sync Position   | Write Only | 10H         | 10H         | 00H            |
| R8   | Interlace Mode           | Write Only | 02H         | 00H         | 00H            |
| R9   | Maximum Scan Line        | Write Only | 07H         | 07H         | 00H            |
| R10  | Cursor Start             | Write Only | 00H         | 00H         | 00H            |
| R11  | Cursor End               | Write Only | 00H         | 00H         | 00H            |
| R12  | Start Address (H)        | Read/Write | 00H         | 00H         | 00H            |
| R13  | Start Address (L)        | Read/Write | 00H         | 00H         | 00H            |
| R14  | Cursor (H)               | Read/Write | 00H         | 00H         | 00H            |
| R15  | Cursor (L)               | Read/Write | 00H         | 00H         | 00H            |

## PROGRAMMING THE DISPLAY MEMORY

In the Color/Graphics Emulation Modes, 16K bytes of display memory are located at addresses 80000H-8FFFFH. This memory is used for any display mode selected by the Mode Control Register.

The color/graphics display memory can always be read or written (unless disabled by the COLON jumper), even while the display adapter is in another mode. Unlike I/O ports, however, reading from or writing to display memory does not change the state of the screen. This allows programs to clear display memory before reprogramming the I/O registers for a new display mode.

**Caution--**The same physical memory is used for all of the modes of the display adapter. Therefore, do not write to monochrome memory when in color/graphics emulation mode, unless you immediately reprogram the I/O registers for the new display mode.

### Alphanumeric Modes

The display memory in the alphanumeric modes supports either four screens of 80 columns by 25 rows, or eight screens of 40 columns by 25 rows. Any of the alphanumeric screens can be displayed by programming the 6845 Screen Start Registers.

The display adapter supports 256 different characters contained in ROM. The characters are organized the same as in Monochrome Emulation Mode, with each character represented by one byte at an even address for the character code and one byte at the following odd address for the attribute.

The codes for the attributes are shown in Table 4-3.

Table 4-3 Character Attributes (Monochrome Mode)

| Hex | Binary   | Attribute |
|-----|----------|-----------|
| 00  | 00000000 | Normal    |
| 01  | 00000111 | Normal    |
| 70  | 01110000 | Reverse   |
| 08  | 00001000 | Normal    |
| 0F  | 00001111 | Normal    |
| 87  | 10000111 | Normal    |
| 88  | 10001000 | Normal    |
| 8F  | 10001111 | Normal    |
| F0  | 11110000 | Reverse   |

Note that the attributes for alphanumeric modes are the same as Monochrome Mode, except that the intensity attribute instead of an underline attribute.

### Graphics Modes

The display memory in the IBM graphics emulation modes supports a single graphics screen with either of two resolutions: 200 or 320 by 200. The 160 by 100 low-resolution graphics mode of the IBM Color/Graphics Display Adapter is not supported.

Table 4-4 shows the memory scheme for the graphics modes.

Table 4-4 Memory Scheme - Graphics Modes

| Scan Line | First Byte | Last Byte |
|-----------|------------|-----------|
| 0         | B8000H     | B800FH    |
| 1         | B8000H     | B800FH    |
| 2         | B8000H     | B800FH    |
| 3         | B8000H     | B800FH    |
| 4         | B8000H     | B800FH    |
| 5         | B8000H     | B800FH    |
| ...       | ...        | ...       |
| 196       | B8E00H     | B8E0FH    |
| 197       | B8E00H     | B8E0FH    |
| 198       | B8E00H     | B8E0FH    |
| 199       | B8E00H     | B8E0FH    |

Note that the even and odd scan lines are divided into separate banks of memory, with even scan lines from B8000H through B800FH, and odd scan lines from B8000H through B800FH. Each scan line uses 80 (50 hex) bytes of display memory, with the first byte of each scan line displayed on the left, and the last byte displayed on the right.

## 5 ACCESSING THE EXTENDED BIOS

The extended alphanumeric mode is accessed by issuing the "extended" function of IBM BIOS (see Table 5-1). To access the extended BIOS, set AH = 0, AL = 0, and set AH = 0, AL = 0.

Table 5-1 AL Values For IBM Interrupt 10H

| AL Value | Mode                     |
|----------|--------------------------|
| 0        | 40 X 25 BW ALPHA         |
| 1        | 40 X 25 COLOR ALPHA      |
| 2        | 80 X 25 BW ALPHA         |
| 3        | 80 X 25 COLOR ALPHA      |
| 4        | 320 X 200 COLOR GRAPHICS |
| 5        | 320 X 200 BW GRAPHICS    |
| 6        | 480 X 200 BW GRAPHICS    |
| 7        | 80 X 25 MONOCHROME ALPHA |
| 8        | 80 X 25 ALPHA            |
| 9        | 80 X 50 ALPHA            |
| 10       | 160 X 25 ALPHA           |
| 11       | 160 X 50 ALPHA           |

Note--The extended screen driver must be loaded by issuing the "extended" command with a LOAD parameter (see the Extended BIOS section of the extended BIOS can be accessed.

You can also set AH = 0FH to employ the "extended" mode of the interrupt 10h, and then examine AL to find out which display mode is currently selected. The values for the modes are the same as for set mode, and are shown in Table 5-1.

## 6 CUSTOMISING THE 8086 CHARACTER SET

Standard Character Set...

Custom Character Sets



## STANDARD CHARACTER SET

The characters displayed in the alphanumeric modes are defined in a 16 by 16 character cell. These cells are stored in two ROMs on the display adapter. Each of the 16 character lines of each cell are doubled on the display, yielding a physical character cell size of 16 by 32. The standard character set supplied with the display adapter includes all 256 standard IBM characters.

## CUSTOM CHARACTER SETS

Custom character sets may be generated by substituting custom ROMs for the standard ROM set. Either one or two character sets may be stored in the character ROMs. If only one character set is required, 256 nanosecond 2732 ROMs may be used. If you want two character sets, you must use 256 nanosecond 2764-type ROMs.

The two possible character sets are called the "primary" and "alternate" fonts, and are stored at the following ROM addresses.

|                |             |
|----------------|-------------|
| Primary Font   | 0-FFFF      |
| Alternate Font | 1000H-1FFFF |

The font is selected with the FONT utility, as described in the User's Guide.

You define the character sets on custom ROMs by storing the left half (left-most eight pixels) of each character in the ROM marked "CHARL" at the IC location labeled "LEFT", and the right half of the character in the ROM marked "CHARR" at the IC location labeled "RIGHT".

The 16 character lines of the first character are stored in the first 16 bytes of each ROM, and the other 255 characters follow sequentially.

Note--Only one character set may be stored in a ROM. If you want two character sets, you must use 256 nanosecond 2764-type ROMs. The character code is doubled to find the appropriate ROM.

For example, the character code for the letter 'E' is 00000111. The appropriate ROM is 00000111 \* 2 = 00000110, or 00000110H.

| Character Code (16 bits) | Primary Font Address | Alternate Font Address |
|--------------------------|----------------------|------------------------|
| 00000000                 | 00000000H            | 10000000H              |
| 00000001                 | 00000001H            | 10000001H              |
| ...                      | ...                  | ...                    |
| 00000015                 | 00000015H            | 10000015H              |
| ...                      | ...                  | ...                    |
| 000000FF                 | 000000FFH            | 100000FFH              |

Table 4-1 shows how a custom ROM set may be constructed for the primary font.

Table 4-1 Character ROM Example

| Pattern           | Address | CHARL | CHARR |
|-------------------|---------|-------|-------|
| .....             | 0420H   | 00H   | 00H   |
| .....             | 0421H   | 00H   | 00H   |
| ..XXXX XXXX..     | 0422H   | 3FH   | 3FH   |
| ...XXXX ..XXXX..  | 0423H   | 0FH   | 3CH   |
| ....XXXX ...XXXX. | 0424H   | 0FH   | 1CH   |
| ....XXXX ..XXXX.  | 0425H   | 0FH   | 1CH   |
| ....XXXX ..XXXX.. | 0426H   | 0FH   | 3CH   |
| ....XXXX XXXX..   | 0427H   | 0FH   | 3CH   |

Table 6-1 Continued

| Pattern          | Address | CHASL | CHANS |
|------------------|---------|-------|-------|
| ...XXXX ..XXXX.. | 0425H   | 0FH   | 3CH   |
| ...XXXX ..XXXX.. | 0426H   | 0FH   | 1EH   |
| ...XXXX ..XXXX.. | 0427H   | 0FH   | 1EH   |
| ...XXXX ..XXXX.. | 0428H   | 0FH   | 3CH   |
| ..XXXXXX XXXX... | 042CH   | 3FH   | F8H   |
| .....            | 042DH   | 0CH   | 0CH   |
| .....            | 042EH   | 0CH   | 0CH   |
| .....            | 042FH   | 0CH   | 0CH   |

INDEX

## A

## Addresses

character sets, 8-4  
 color/graphics emulation  
 display memory, 8-6  
 CRT Control Port 1, 3-2  
 CRT Controller Registers -  
 color/graphics modes, 4-6  
 CRT Controller Registers -  
 monochrome emulation  
 mode, 3-4  
 CRT status port, 3-3, 8-8  
 display memory, 1-8  
 display pages in black and  
 white 640 x 400 mode, 2-10  
 display pages in gray scale  
 320 x 400 mode, 2-10  
 fonts, 6-2  
 I/O ports, 1-4  
 Mode Control Register, 4-2  
 monochrome emulation  
 display memory, 3-6  
 native control port, 2-2  
 native screen start  
 ports, 2-2  
 starting ROM for a  
 character, 6-3

Character sets  
 Color/graphics emulation  
 CRT Control Port 1  
 CRT Controller Registers  
 CRT status port

Display memory  
 Display pages in black and  
 white  
 Display pages in gray scale  
 Fonts  
 I/O ports  
 Mode Control Register  
 Monochrome emulation  
 Native control port  
 Native screen start  
 Ports  
 Starting ROM for a character

## C

## Characters

attributes for color  
 graphics emulation, 8-4  
 attributes for monochrome  
 emulation, 3-6  
 cell size, 6-2  
 custom character set, 8-2  
 ROM addresses, 6-2  
 custom example, 6-3  
 COLOR jumper, 4-2, 8-6  
 Compatibility  
 devices and, 1-3  
 IBM Display Adapters, 1-

Character sets  
 Color/graphics emulation  
 CRT Control Port 1  
 CRT Controller Registers  
 CRT status port  
 Display memory  
 Display pages in black and  
 white  
 Display pages in gray scale  
 Fonts  
 I/O ports  
 Mode Control Register  
 Monochrome emulation  
 Native control port  
 Native screen start  
 Ports  
 Starting ROM for a character

Constructing a custom character, 8-3  
CMT Control Port 1 values for monochrome emulation, 3-3  
CMT Controller Registers values for color/graphics emulation, 4-5  
values for monochrome emulation, 3-5  
CMT status port, 3-3

D  
Display memory, 1-4  
color/graphics emulation, 4-6  
monochrome emulation, 3-5  
pages, 2-9  
Display modes, 1-2

G  
Gray scales, 1-5

I  
I/O ports, 1-4  
Interrupt 10H, 5-1

M  
Memory addresses, 1-4  
Memory pages, 3-2  
Memory schemes  
black and white 1280 x 400 mode, 2-8  
black and white 1280 x 800 mode, 2-7  
black and white 640 x 400 mode, 2-10

Memory schemes (continued)  
gray scale 320 x 400 mode, 2-10  
gray scale 640 x 400 mode, 2-8  
gray scale 640 x 800 mode, 2-7  
IBM graphics modes emulation, 4-8  
Mode Control Register values for color/graphics emulation, 4-4  
MONO jumper, 3-2, 3-6

N  
Native control port values for black and white 1280 x 400 mode, 2-7  
values for black and white 1280 x 800 mode, 2-5  
values for black and white 640 x 400 mode, 2-9  
values for gray scale 320 x 400 mode, 2-9  
values for gray scale 640 x 400 mode, 2-7  
values for gray scale 640 x 800 mode, 2-5

Native control ports  
native graphics modes, 2-2  
Native screen start ports  
native graphics modes, 2-2  
Native screen start values  
black and white 1280 x 400 mode, 2-8  
black and white 1280 x 800 mode, 2-6

Native screen start (continued)  
black and white 640 x 400 mode, 2-9  
gray scale 320 x 400 mode, 2-9  
gray scale 640 x 400 mode, 2-8  
gray scale 640 x 800 mode, 2-6

P  
Pages in memory, 3-2  
Physical memory, 1-4, 3-6, 4-4  
Pixel displays, 1-5

S  
Scan lines, 4-6  
SCREEN command  
extended BIOS and, 5-1  
Scrolling the display, 2-4

#### FCC NOTICE

**WARNING:** This equipment must be used in accordance with frequency, voltage, and current ratings and with the instructions in the instruction manual and with the safety precautions. The equipment has been tested and found to comply with the requirements of Part 15 of the FCC rules, providing that the following conditions are met: (1) This equipment is designed to provide reasonable protection against radio interference when operating in a commercial, industrial, or business environment; (2) The equipment is shielded so that the radio frequency energy it emits or receives does not exceed the limits specified in the FCC rules, which may be required to protect against interference to other licensed operations.

Only devices certified to comply with the FCC rules for Class B computing devices may be attached to this equipment. Connecting any unshielded device is likely to result in unauthorized use of the equipment.

This equipment is intended for commercial, industrial, or business operation in Class B environments.

The use of shielded I/O cables is required to maintain compliance with the FCC rules and all approved peripheral or host device manufacturers to determine which FCC rules.

© 2000 by Wyse  
Company, Inc.  
Dallas, Texas 75243

Wyse Technology  
Company, Inc.  
10000 North Central  
Expressway, Suite 1000

WYSE  
TECHNOLOGY